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ARTIFICIAL DIET: THE KEY TO THE MASS REARING OF *MEGATHYMUS* LARVAE

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TECHNIQUES FOR REARING *Megathymus* larvae utilizing yucca caudices were discussed by Wielgus and Wielgus (1973). As a medium for rearing, yucca caudices proved to be difficult to preserve in a wholesome state for prolonged periods, were obtainable only with great labor and generally not available to others, and were cumbersome and space-consuming.

Petterson and Wielgus (1974) discussed a method of introduction and acceptance of an artificial medium by *Megathymus streckeri* (Skinner) larvae. The biology of *streckeri* larvae made rearing on yucca caudices extremely difficult (and hazardous to the larvae during the transfer process) so a more suitable substitute was devised in the form of artificial diet and man-made containers. Simultaneous with rearing *streckeri* larvae, the artificial diet substitute was used successfully with the larvae of other *Megathymus* species.

In 1974, 52 *streckeri* and 30 *Megathymus texanus texanus* B. & McD. ova were obtained and the newly-hatched larvae successfully started and established on artificial diet. Later that same year, several *Megathymus ursus ursus* Poling ova were collected and the newly-hatched larvae were also started and established on artificial diet with no difficulty.

Megathymus species split into two natural groups based mainly upon larval biologies, but also upon distinct pupal differences. The first group ("tent-builders") includes all of those species whose larvae construct and maintain tents throughout the feeding period. The other group ("non-tent-builders") are all of those species whose larvae construct tents after the feed-

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Fig. 1.—Plastic ice cream container with four *Megathymus ursus* larvae reared on artificial diet in PVC pipe sections. Scale in inches.

Fig. 2.—Closeup view of rolled paper tents shown in Fig. 1. from which *ursus* larvae have constructed silken tents. Dark particles adhering to tents are frass pellets. Scale in inches.

ing period and just prior to pupation. The latter group includes *Megathymus cofaqui* (Strecker), *Megathymus harrisi* Freeman, *Megathymus texanus texanus* B. & McD., *Megathymus texanus leussleri* Holland and *Megathymus streckeri* (Skinner).

The larvae of both groups present unique problems to rear- ing on artificial diet based mainly upon behavioral patterns. The basic problems, however, are 1) diet acceptance and estab- lishment, 2) containment of the diet and larvae, 3) confinement of the larvae, and 4) replenishment of the diet and/or transfer of the larvae to fresh diet. The techniques developed and dis- cussed herein have proven quite adequate for rearing scores of *Megathymus* larvae under completely artificial conditions. Larvae just newly-hatched, or field-collected in various instars, have been established on diet and successfully reared to adults in the laboratory utilizing these techniques.

Introduction and acceptance of artificial diet by *Megathymus* larvae is easily accomplished by the insertion of a small plug of yucca pulp into the diet. The yucca used is the native foodplant species of each *Megathymus* taxon being reared. One small (40 mm in diameter by 10 cm in length) yucca caudex will produce hundreds of plugs, and the unused portion of caudex may be stored in a household refrigerator for several months if properly sealed in plastic wrapping (freezer wrap).

TENT-BUILDERS

Containment of the diet differs for both larval groups. For the tent-builders, the author uses sections of Polyvinylchloride (PVC) irrigation pipe 24 mm in inside diameter by 80 mm in length which have been filled with diet. One end of the pipe is capped with a square of sheet aluminum 27 mm on a side by 0.5 mm in thickness which is taped to the pipe. The other end of the pipe is capped with a square of clear plastic sheet of approximately the same dimensions. In the center of each plastic square, a small hole is cut for the insertion of an artificial tent of rolled paper. The paper tent is pushed into the diet so that it surrounds the yucca plug inserted earlier. Then an ovum, still attached to a portion of the yucca leaf, is placed into the paper tent to await hatching, or, a larva in any instar is allowed to make its way into the tent and establish itself. Containers of this type, properly labeled, are placed upright in various small boxes, plastic bowls, etc., and maintained at room temperature. Larval transfers are easily accomplished and later, as the larvae mature, only a wrapping of polyethylene plastic is used to

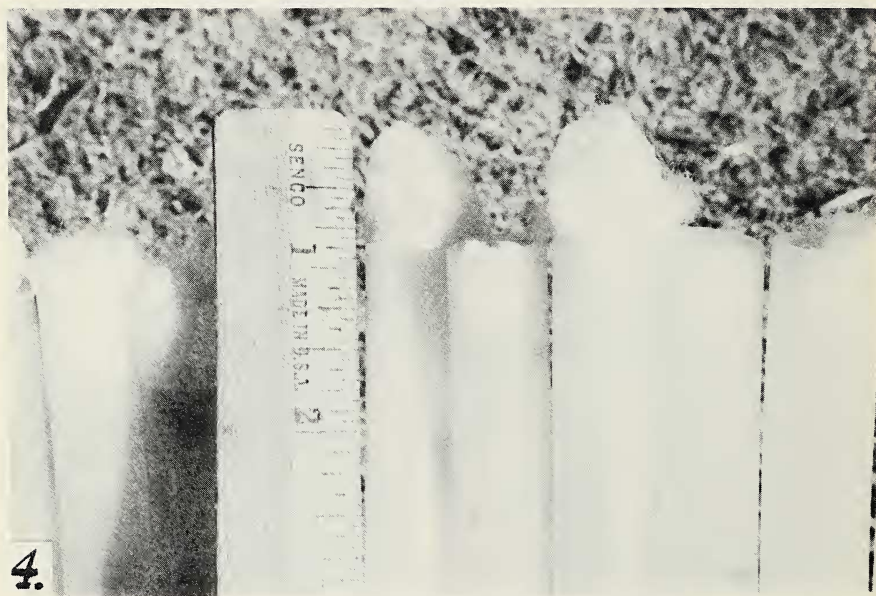
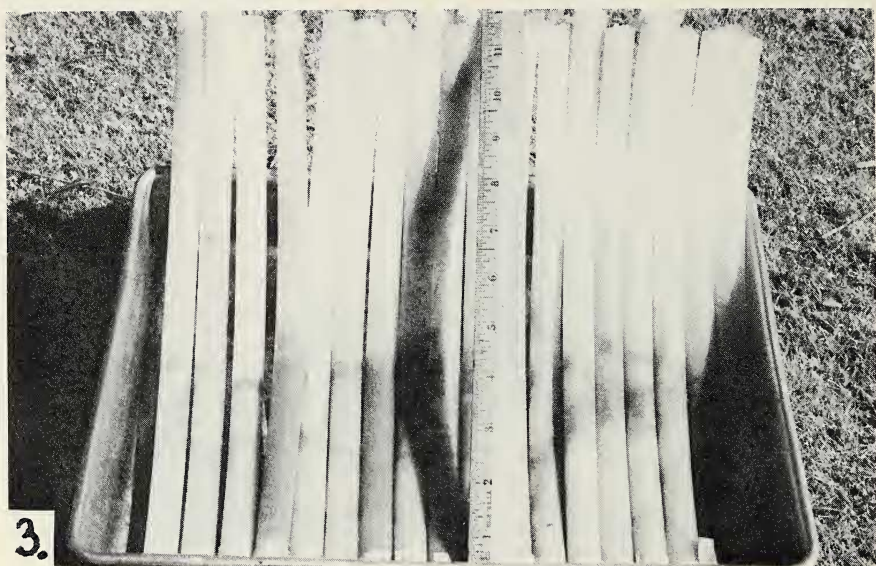


Fig. 3.—Metal tray container holding several *Megathymus streckeri* and *Megathymus texanus texanus* larvae reared on artificial diet in plastic tubes. Scale in inches.

Fig. 4.—Closeup view of plastic tube ends shown in Fig. 3. with two short tents made by *streckeri* larvae. Note that the cotton plugs have been incorporated into the tents. Scale in inches.

encase the PVC pipe ends in order to reduce moisture loss of the diet through evaporation. In some instances, a few larvae may begin to bore out of the bottoms of the pipes through the plastic wrapping. If the pipes have been set upon metal or tough plastic containers, further boring out is prevented. Tent-building larvae will defecate outside of the tent and the fecal pellets will accumulate on the bottoms of the boxes, etc. Mature larvae will powder up and pupate in their surrogate yucca caudices (pipes) after several months of feeding. Under laboratory conditions, the feeding period is markedly shortened and diapause may be non-existent or brief (lasting a few weeks instead of months).

NON-TENT-BUILDERS

For the non-tent-builders, the problems of rearing are more acute. Containers must be impenetrable to larval mandibles. In the early instars (up through fourth instar), the larvae of *streckeri* and *texanus* are notorious borers and must be confined at all costs. Otherwise, they may bore out unnoticed and escape, never to be found again, or discovered many days or weeks later in a state of severe desiccation.

Virtually all of the non-tent-building larvae reared by the author have been ex ova. The initial container is an ordinary plastic drinking straw filled with diet to within 20 mm of one end. The end of the straw destined to be the bottom is folded over and stapled down. The other end of the straw receives a small yucca plug which is pushed into the diet a short distance. Then an ovum, still attached to a portion of a yucca leaf, is introduced into the straw and the straw end folded over and stapled. The newly-hatched larvae will bore into the yucca plugs and ultimately into the diet. The straws, in clusters of twenty or more, are stood upright in ordinary glass jelly jars which have been properly labeled. As the larvae feed on the diet and moult, they are observed through the clear plastic. Frass is packed into the straws behind them. Before their diet is all consumed, the larvae may have outgrown the straws and will need to be transferred.

The next container is an intermediate one and consists of a semi-transparent polyethylene plastic tube 9 mm in inside diameter by 30.5 cm in length with a wall thickness of approximately 2 mm. This size will allow *streckeri* and *texanus* larvae to feed up through the fifth instar. The tube is filled with diet to within 4 cm of one end. At this end the larva is allowed to

make its own way in. Both ends of the tube are then capped with squares of sheet aluminum 10 mm on a side by 0.5 mm in thickness taped in place. The aluminum prevents boring out and escape of the larva. Sufficient air is present in the diet and the tube to allow for larval respiration. The larva is easily observed through the semi-transparent plastic. Ecdysis is accurately determined and exuviae readily recovered utilizing plastic tube containers.

The final container is similar to the intermediate one, the only difference being one of greater inside diameter. In this case, tubes measuring 12 mm in inside diameter are used. Larvae well into fifth instar and beyond will still require that aluminum caps be placed over the bottom ends of the tubes. The upper ends (tubes are placed upright or with one end higher than the other in various containers) however, from which the larvae will construct their tents, are plugged only with wads of cotton. The larvae will defecate against the cotton plugs. Later, after diapause, they will push out the cotton plugs or bore through them when tent building is initiated.

At any time during the rearing, it may become necessary to transfer the larvae to fresh diet. For non-tent-builders, removal of each larva is a simple matter. First, uncap both ends of the tube. Second, hold the tube so that the bottom end is above a level surface a few centimeters. Then, blow into the upper end of the tube with gentle but sustained pressure. This will force the contents of the tube (including larva) out of the bottom end and onto the surface. Thereupon, the larva may be collected, inspected and introduced to a new container.

The ideal container for a non-tent-building larva appears to be one in which the inside diameter of the tube corresponds exactly to the larval one. Non-tent-building larvae are notoriously wasteful if given a column of diet greater than their larval diameter.

The habit of plugging the burrow behind them with frass as they feed (in contrast to the tent-builders) exposes the non-tent-builders to the hazards of fungus and bacteria which may culture within the tubes. Aside from vigilance and transfer to fresh diet when this problem arises, the author has not found a satisfactory solution. Consequently, losses due to disease are much greater with laboratory reared non-tent-building larvae than with the tent-builders.

CONCLUSION

The use of artificial diet for the rearing of *Megathymus* larvae affords an opportunity to other workers interested in this genus. Under controlled laboratory conditions, resources permitting, there appears to be little limitation to the number of larvae or taxa involved which one can successfully rear to adults. Larval duration can be significantly reduced (depending upon the taxon) from a time span of around ten months to as little as 120 days from egg to adult by employing the techniques described herein.

It is hoped that the techniques presented in this paper will encourage others in the rearing of *Megathymus* larvae. Those who will try their hand at rearing these fascinating beasts are urged to try other techniques. By taking advantage of their innate larval behavior, the worker will find *Megathymus* larvae relatively simple to rear.

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